Technology Opportunity
Glenn Research Center • Cleveland • Ohio
Technology Transfer & Partnership Office
TOP3–00148

PMR Polyimide Extended Shelf Life Technology

R&D 100 Award Recipient in Year 2000

Technology

This patented technology uses isopropyl ester acids and isopropanol solvent to extend the shelf life and reduce the cost of polymerization of monomeric reactants (PMR) materials.

Benefits

This new technology offers many benefits to PMR polyimide manufacturers:

- Shelf life is increased by as much as a factor of 30 (fig.1)
- Material scrap and variation is reduced because of improved material stability
- Need for refrigerated transportation and storage can be eliminated
- Safety is improved because isopropanol is less toxic and flammable than primary alcohols
- PMR system costs are reduced

Commercial Applications

- Aircraft engine composite components
- Aircraft airframe composite components
- Nonaerospace polyimide composite components such as bearings and bushings

Technology Description

High-temperature polyimides such as PMR–15 are becoming an increasingly important class of materials for a variety of applications. However, a major barrier to more widespread use of these materials is their high cost and limited shelf life. Recent efforts

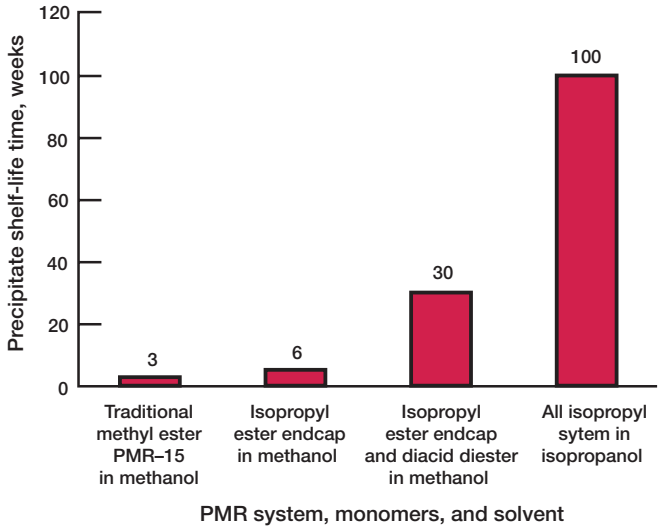

Figure 1.—PMR–15 solution stability as a function of precipitation time.

at Glenn Research Center have addressed these various undesirable features of PMR materials, with the purpose to improving shelf life and reducing the cost of PMR materials. This objective has been accomplished with the development of PMR extended shelf life technology that uses isopropyl ester acids and isopropanol solvent to replace methyl or ethyl ester acids, and methanol or ethanol solvents that are currently used in state-of-the-art PMR technology. This change results in dramatically increased shelf life and reduced costs.

The main improvement resulting from changing to isopropyl ester acids and isopropanol solvent in PMR materials is reduced reactivity. At a comparable temperature, shelf life is typically extended by an order of magnitude, and as high as 30-fold increases have been demonstrated. These shelf life improvements are seen in both increased time for precipitate formation at room temperature stored,

50 percent solids, in the PMR solutions as shown in figure 1 and in the amount of soluble reaction products in PMR monomer solutions and prepregs as measured by high-pressure liquid chromatograph as shown in figure 2. Similar shelf life improvements have been demonstrated for other polyimides developed at Glenn such as PMR II–50, VCAP–75, BAX PMR, and also for polyimides developed elsewhere such as AFR 700–B and RP–46.

Reduced reactivity is also reflected in increased tolerance to high-temperature mishandling. For example, PMR–15 solution and prepreg that is made with isopropanol may be stored or handled at temperatures 50 °C higher than comparable PMR–15 material made with methanol, with the same amount of imidization products then formed in both. It is important to note that changing to isopropyl ester acids and isopropanol solvent does not raise typical imidization for curing temperatures.

Improved stability leads to reduced costs through all phases of PMR usage: synthesis, manufacturing, shipping, handling, storage, and fabrication. Increased tolerance to high-temperature excursions can eliminate the need for refrigeration or monitoring of temperature histories. Extended shelf life reduces the amount of out-of-specification material, which leads to better process control, reduced variation among batches, and reduced scrap rates.

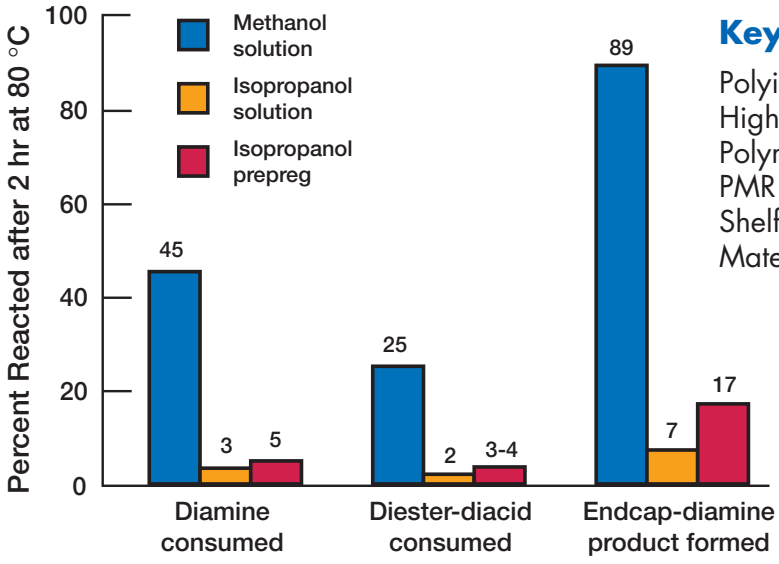

Figure 2.—PMR–15, monomers consumed, and products formed.

An additional benefit of using isopropanol solvent and isopropyl ester acids based PMR materials is improved safety. Compared to methanol and ethanol, isopropanol is less toxic and less flammable. Improved safety also has the effect of reducing cost by reducing the level of safety requirements for handling these materials.

Options for Commercialization

This extended shelf life technology has been bundled with other high-temperature-polymer technologies developed at NASA Glenn Research Center, and is available for licensing to produce new and improved commercial products.

Contact

Technology Transfer & Partnership Office
NASA John H. Glenn Research Center
at Lewis Field
Mail Stop 4–2
Cleveland, OH 44135–3191
Phone: 216–433–3484
Fax: 216–433–5012
E-mail: ttp@grc.nasa.gov
http://technology.grc.nasa.gov

References

NASA Tech Briefs (September 2000)
LEW16691–1
U.S. Patent 6,103,864 (August 15, 2000)

Key Words

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Shelf life
Materials